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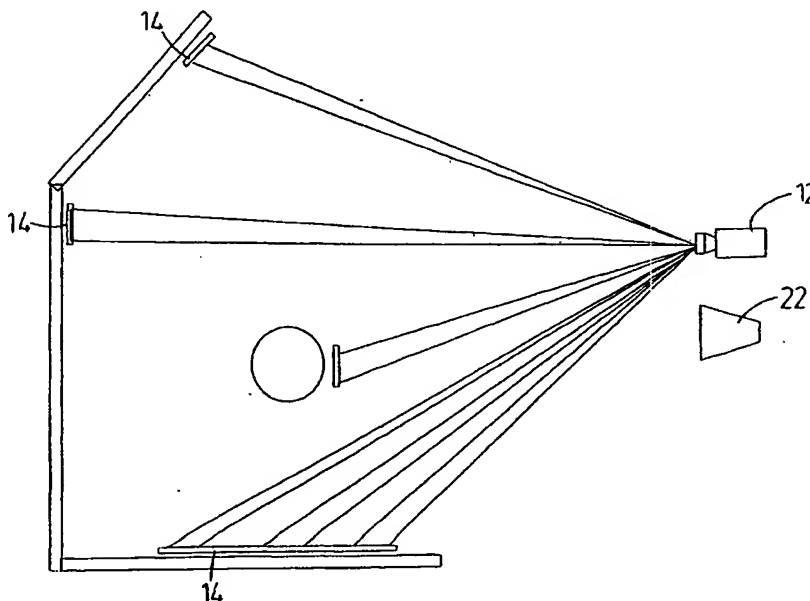
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(54) Title: **INTRUDER ALARM SYSTEM**



(57) Abstract: This invention relates to an intruder alarm system and more particularly to an intruder alarm system using image capturing means to capture images of a reference surface device located in a surveillance area. The intruder alarm system includes image capture means for capturing images of a reference surface on a reference surface device, the reference surface having sections of different reflective characteristics. A comparator compares the contrast between the sections on the reference surface and causes an alarm actuator to actuate an alarm when the contrast is below a predetermined amount.

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INTRUDER ALARM SYSTEM

5 Field of the Invention

This invention relates to an intruder alarm system and more particularly to an intruder alarm system using image capturing means to capture images of a reference surface device located in a surveillance area.

10

Background to the Invention

Numerous systems are available on the market to detect the unauthorised entry of intruders in an area or on a property or to deter unauthorised
15 persons from entering the property.

In the outdoors, systems comprising optical, radiation or microphone sensors, magnetic field sensors and/or electric fencing are commonly used to deter unauthorised persons from entering a property and/or to detect
20 unauthorised entry into a surveillance area or property. These systems are labour intensive to install, in most cases require the installation of cables and expert installation of sensors and, as a result, may be expensive.

Video surveillance detectors are generally known and are used to detect
25 motion by comparing a video frame, or part thereof, to previous instances of the video frame taken of the same surveillance area. United States Patent

number 3,988,533 discloses a motion and intrusion detection system that utilises video techniques to sample fixed points during a video scan of the field view of a camera and stores information concerning the fixed scanned points. The information on respective scanned points obtained during
5 subsequent scans is compared with a previous frame and threshold conditions are set up to detect an alarm condition. Setting alarm conditions can be problematic as alarm situations need to be clearly defined and distinguished from regular day-to-day occurrences and changes in ambient conditions.

10

United States Patent number 6,104,755 discloses a method for measuring the motion in a video image by calculating both the field-difference and the frame-difference of consecutive video images. Image data of a set of first pixels in a frame are compared to image data of a second set of pixels in a
15 second frame that are spaced from the first set (in respective prior rows, for example). The minimum frame-difference motion value, calculated from these comparisons, is input into a logical mixer. The motion of the video image must be compared against a threshold value which may be difficult to determine, given changing conditions caused by natural phenomena, such as
20 wind.

Infa-red beams, ultra-sonic movement sensors and video motion detectors, can also be used to detect an intruder in the grounds surrounding a building but the incidence of false alarms can be high due to the unpredictable nature

of external phenomena such as swaying trees, the movement of domestic animals, birds and the like.

In this specification the term "contrast" shall mean the difference between a
5 number of pixels of an image corresponding to a first section of a reference surface on a reference surface device and a number of pixels of an image corresponding to a second section of a reference surface on a reference surface device, the first and second sections having different reflective characteristics.

10

Object of the Invention

It is an object of the present invention to provide an intruder alarm system which, at least partially, alleviates some of the abovementioned difficulties.

15

Summary of the Invention

In accordance with this invention there is provided an intruder alarm system comprising an image capturing means for capturing an image of a surveillance
20 area including an image of at least one reference surface device in the surveillance area, the reference surface device having a reference surface with at least two sections of different reflective characteristics; a comparator for calculating a contrast between the sections; and an alarm activator for activating an alarm when the contrast is a predetermined amount.

25

Further features of the invention provide for the alarm means to activate the alarm when the contrast is below a predetermined amount; for the comparator to compare the mean tone of a number of pixels in the image corresponding to a first of the two sections to the mean tone of a number of pixels in the image corresponding to a second of the two sections; for the comparator to cause the alarm activator to activate an alarm when the mean tone of the number of pixels corresponding to the first section and the mean tone of the number of pixels corresponding to the second section differ by less than a predetermined amount; for the comparator to cause the alarm activator to activate an alarm when the mean tone of the number of pixels corresponding to the first section and the mean tone of the number of pixels corresponding to the second section is substantially equal; for the alarm to be activated when the contrast of at least two reference surface devices is below a predetermined level; for the alarm to be activated when the contrast of a predetermined set of reference surface devices is below a predetermined level; for the predetermined set to define a predetermined two dimensional pattern; for the predetermined set to be at least every second or more devices in a row of devices; for the image capturing means to capture an image at predetermined intervals; for a light source to be included for illuminating the reference surface; for the image capturing means to capture an image including a plurality of reference surface devices to facilitate the recognition of an object larger than any one of the reference surfaces with a pattern recognition means; for the reference surface devices to be arranged proximate each other; for the reference

surface devices to be arranged in a predetermined pattern; for the predetermined pattern to be a row; for the predetermined pattern to be a matrix; and for the pattern recognition means to be software stored in a memory means of the system.

5

A further feature of the invention provides for the intruder alarm system to include pattern recognition means for identifying a source of disturbance when the contrast is outside the threshold range. In one embodiment of the invention
10 the pattern recognition means is in the form of a neural network.

According to a still further feature of the invention the contrast is the differential between a mean tone of a number of pixels in the dark and light sections of the reference surface in an image.

15

Still further, the image capture means captures images at predetermined time intervals.

A further feature of the invention provides for the intruder alarm system to
20 include a light source. Illumination emitted from the light source will be reflected with varying efficacy by the light and dark sections of the reference surface.

A further feature of the invention provides for the intruder alarm system to capture an image of a plurality of reference surfaces, the reference surfaces being arranged proximate each other.

- 5 The pattern recognition means is configured to recognise an object in the line of sight between the image recognition means and a plurality of reference surfaces.

These and other features of the invention are described in more detail below.

10

Brief Description of the Drawings

A preferred embodiment of the invention is described below, by way of example only, and with reference to the accompanying drawings in which:

15

Figure 1 is a schematic representation of a intruder alarm system according to the invention;

Figure 2 is a front view of a variety of reference surface devices;

20

Figure 3 is a plan view of the reference surface devices positioned in the line of sight of an image capture means in a surveillance area;

Figure 4 is a side view of a image capture means and a reference surface device;

Figure 5 is a front view of reference surface devices in use on a perimeter wall; and

Figures 6 & 7 is a series of images showing a how a source of disturbance is identified with a pattern recognition means.

10 Detailed Description of the Drawings

With reference to the drawings an intruder alarm system is generally indicated by reference numeral 10.

15 Referring to Figure 1, the intruder alarm system 10 has image capture means in the form of a plurality of digital cameras 12 for periodically capturing images of a surveillance area. The captured images are stored in a memory bank 13 such as an integrated circuit memory. The surveillance area includes at least one reference surface device having reference surfaces 14 shown, for
20 example, in figure 2. The reference surfaces 14 have dark and light sections 14a, 14b, as shown in figure 2, so as to provide sections having different reflective characteristics.

The reference surface devices are mountable on any surface or support with an
25 adhesive, nut and bolt engagement means, or the like. The reference surface

devices are located in the line-of-sight of the camera 12 (shown in Figure 3) in a surveillance area to be monitored for intruders.

Computer software is stored in a comparator 16. The comparator may be in
5 the form of a microprocessor.

The comparator 16 compares the pixels of an image, stored in the memory bank 13, corresponding to the dark and light sections 14a, 14b of the reference surface 14 in the stored image and calculates the contrast therebetween.

10

The contrast is calculated as the differential between a mean tone of a number of pixels corresponding to a dark section 14a and a mean tone of a number of pixels corresponding to a light section 14b in a stored image.

15 Referring to figure 4, the camera captures an image of the reference surface 14 in order to average the tone of the pixels in a portion A of the dark section 14a and of a portion B of the light section 14b and the comparator 16 compares and stores these mean values.

20 The intruder alarm system further includes an initiator 20 in the form of a microprocessor which performs a set-up routine when the system is activated. The initiator 20 configures the comparator 16 to calculate the mean tone of a pre-set area of an image. It also ensures that the location or coordinates of all reference surfaces 14 are set-up and that the initial values calculated for the

contrast in respect of each reference surface 14 are within the threshold range. The initiator 20 also controls the operation of the system after initiation.

The system further includes a light source 22. The illumination emitted from the
5 light source 22 will be reflected with varying efficacy by the dark and light sections 14a, 14b of the reference surface 14. In this embodiment, the light source is an infra-red illuminator.

Still further, pattern recognition software for identifying a source of disturbance
10 when the contrast is outside the threshold range is provided and may be stored in a separate memory integrated circuit 24.

In use, a plurality of reference surfaces 14 are positioned in close proximity to each other in the area to be monitored (shown in figure 5). Typically, this area
15 will be a perimeter wall, door frame, window pane, tree, pole or the like. The reference surface devices may be arranged in a matrix or row or any other configuration.

Periodically, images are captured and the contrast between the mean of a
20 portion of the dark and light sections 14a, 14b of each of the reference surfaces 14 is calculated by the comparator.

If the contrast for a particular reference surface is outside a pre-determined threshold range, notice of a disturbance is transmitted to the pattern recognition

software. The position of this reference surface is noted (as shown in figures 6 and 7). The cycle is repeated at regular intervals over a subsequent period, noting the position of the reference surface 14 in which the disturbance is detected. The resulting pattern is used to determine the object of the disturbance, be it an animal, human being, branch of a tree or bird, for example.

It may also be that one image is sufficient to recognise an object in the line of sight in front of a number of reference surface devices.

10

If the pattern recognition software identifies the source of the disturbance as an intruder it causes the alarm actuator 18 to actuate an alarm (not shown). For example, with reference to figures 6 and 7, it can be seen that the pattern caused by a crawling human being and a walking cat will differ. The pattern recognition software includes so called "neural" capabilities and, where an alarm would at first be sounded for the pattern in figure 7, the software can be programmed to in future ignore such a pattern.

Futhermore, with reference to figure 5, the system can be programmed to ignore change in contract of, say, two reference surface devices but not three or more or, alternatively, the simultaneous change in contrast in every second or more devices. This will have the effect that the alarm will not be activated for disturbance of the image by, for example, a bird, but will be activated in the case of the presence of a human as is shown in figure 5.

It is envisaged that the intruder alarm system will be useful in detecting the presence of unauthorised persons in an area without actuating an alarm for disturbances caused by domestic animals, birds, swaying tree branches and
5 other natural phenomena. Ambient light condition will not influence the system as a contrast of the two sections will remain approximately the same under different light conditions. The reference surface devices area also relatively inexpensive to manufacture, install and implement.

10 It will be appreciated that the invention is not limited to the precise details as described hereinbefore. For example, the system need not include a light source but natural light such as moonlight and sunlight may be reflected by the reference surface; the image capture means need not be a digital camera but may be an analogue video camera. Only one reference surface device
15 may be used in which case the image recognition software will not be used and any object that enters the line of sight between the image capture means and reference surface device will set off the alarm. Also, instead of the section having light and dark colouring, the sections may be of different texture and/or shape to have different reflective characteristics.

20

The alarm may be any alarm device such as a sound alarm or a light emitting alarm or a combination of such alarms.

Claims

1. Intruder alarm system comprising an image capturing means for capturing an image of a surveillance area including an image of at least one reference surface device in the surveillance area, the reference surface device having a reference surface with at least two sections of different reflective characteristics; a comparator for calculating a contrast between the sections; and an alarm activator for activating an alarm when the contrast is a predetermined amount.
2. An intruder alarm system as claimed in claim 1 in which the alarm means activates the alarm when the contrast is below a predetermined amount.
3. An intruder alarm system as claimed in any one of the preceding claims in which the comparator compares the mean tone of a number of pixels in the image corresponding to a first of the two sections to the mean tone of a number of pixels in the image corresponding to a second of the two sections.
4. An intruder alarm system as claimed in claim 3 in which the comparator causes the alarm activator to activate an alarm when the mean tone of the number of pixels corresponding to the first section

and the mean tone of the number of pixels corresponding to the second section differ by less than a predetermined amount.

- 5 5. An intruder alarm system as claimed in claim 3 in which the comparator causes the alarm activator to activate an alarm when the mean tone of the number of pixels corresponding to the first section and the mean tone of the number of pixels corresponding to the second section is substantially equal.
- 10 6. An intruder alarm system as claimed in any one of the claims 1 to 3 in which the alarm is activated when the contrast of at least two reference surface devices is below a predetermined level.
- 15 7. An intruder alarm system as claimed in any one of claims 1 to 3 in which the alarm is activated when the contrast of a predetermined set of reference surface devices is below a predetermined level.
8. An intruder alarm system as claimed in claim 7 in which the predetermined set defines a predetermined two dimensional pattern.
- 20 9. An intruder alarm system as claimed in claim 7 in which the predetermined set is at least every second or more devices in a row of devices.

10. An intruder alarm system as claimed in any one of the preceding claims in which the image capturing means captures an image at predetermined intervals.
- 5 11. An intruder alarm system as claimed in any one of the preceding claims including a light source for illuminating the reference surface.
12. An intruder alarm system as claimed in any one of the preceding claims in which the image capturing means captures an image
10 including a plurality of reference surface devices to facilitate the recognition of an object larger than any one of the reference surfaces with a pattern recognition means.
13. An intruder alarm system as claimed in claim 12 in which the reference
15 surface devices are arranged proximate each other.
14. An intruder alarm system as claimed in claim 13 in which the reference surface devices are arranged in a predetermined pattern.
- 20 15. An intruder alarm system as claimed in claim 14 in which the predetermined pattern is a row.
16. An intruder alarm system as claimed in claim 14 in which the predetermined pattern is a matrix.

17. An intruder alarm system as claimed in claim 12 in which the pattern recognition means is software stored in a memory means of the system.

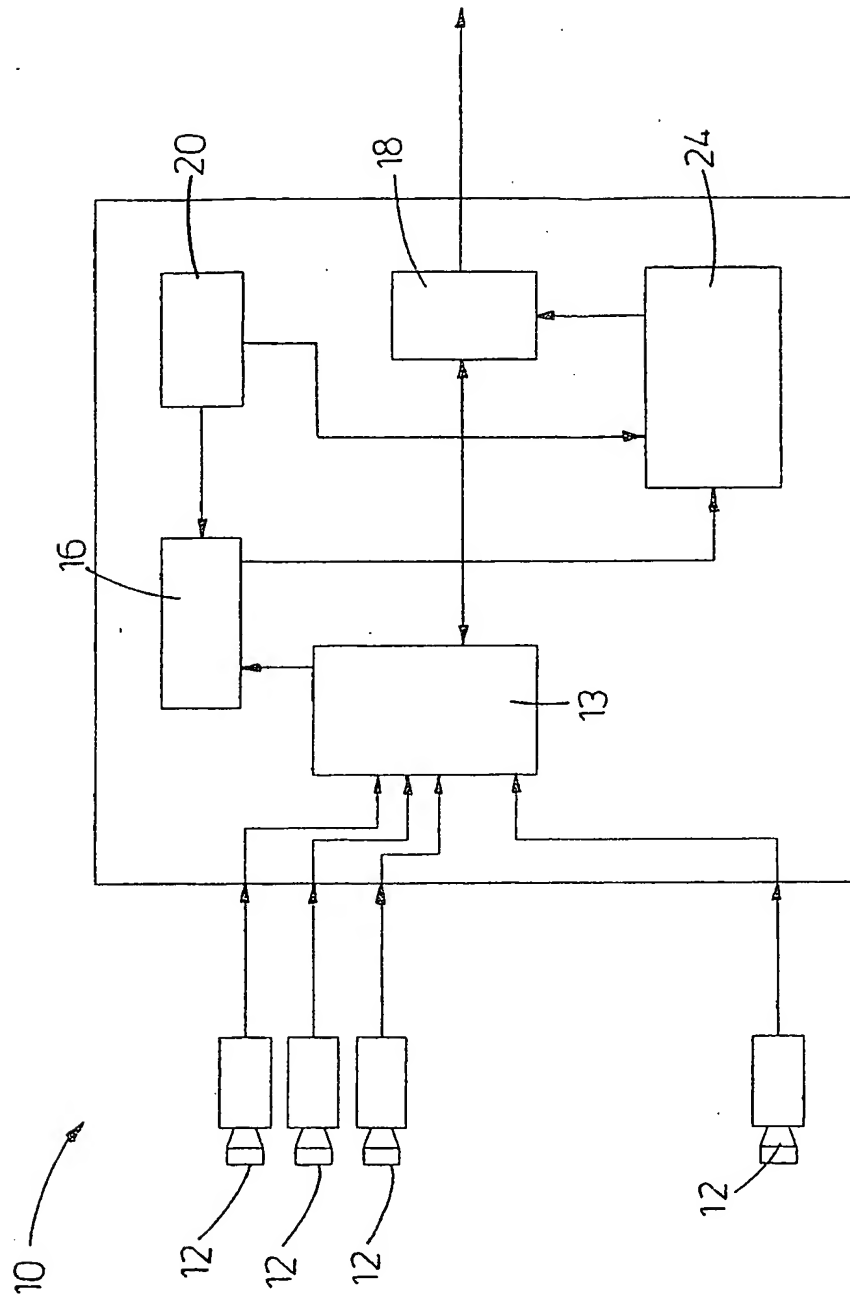


FIGURE 1

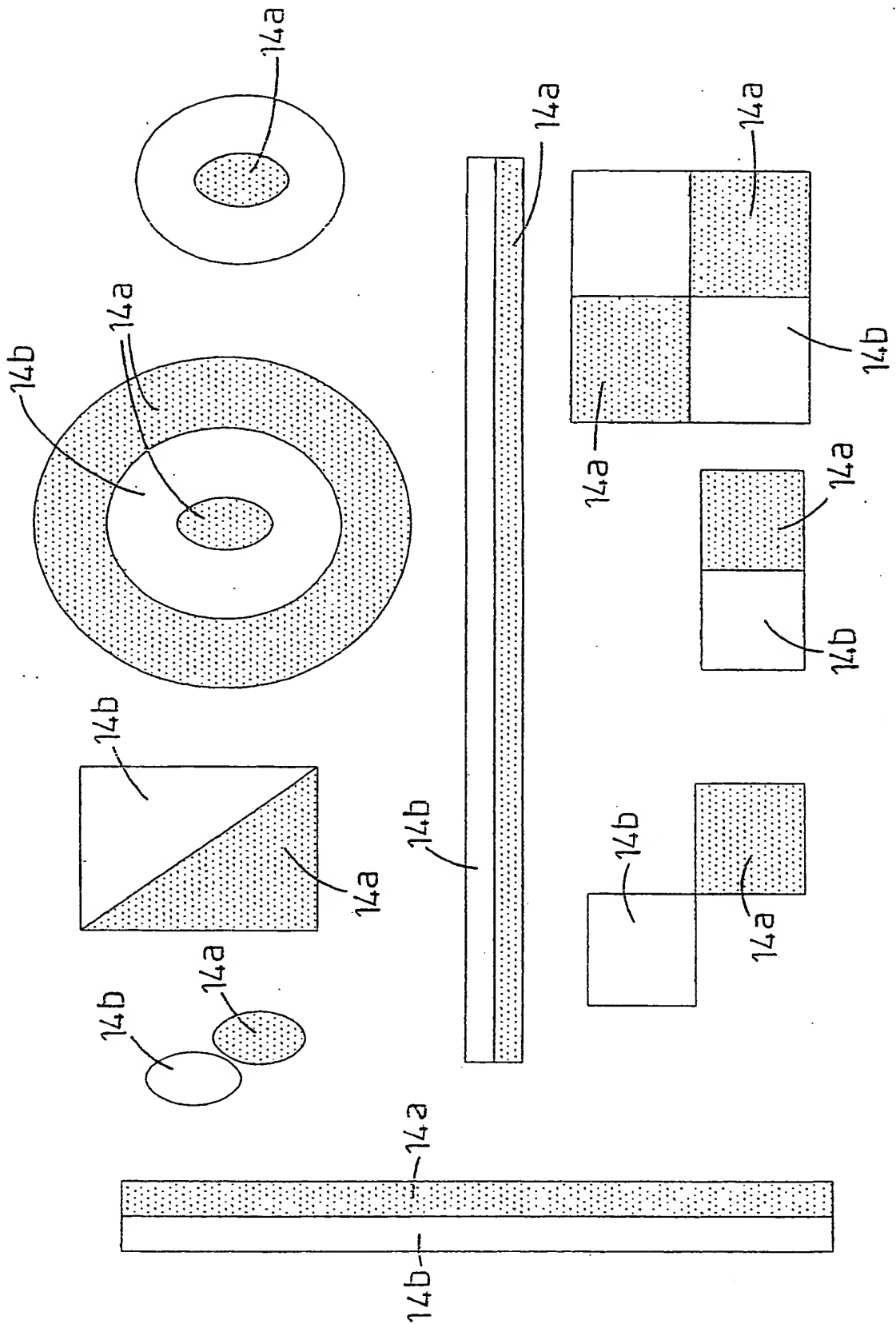


FIGURE 2

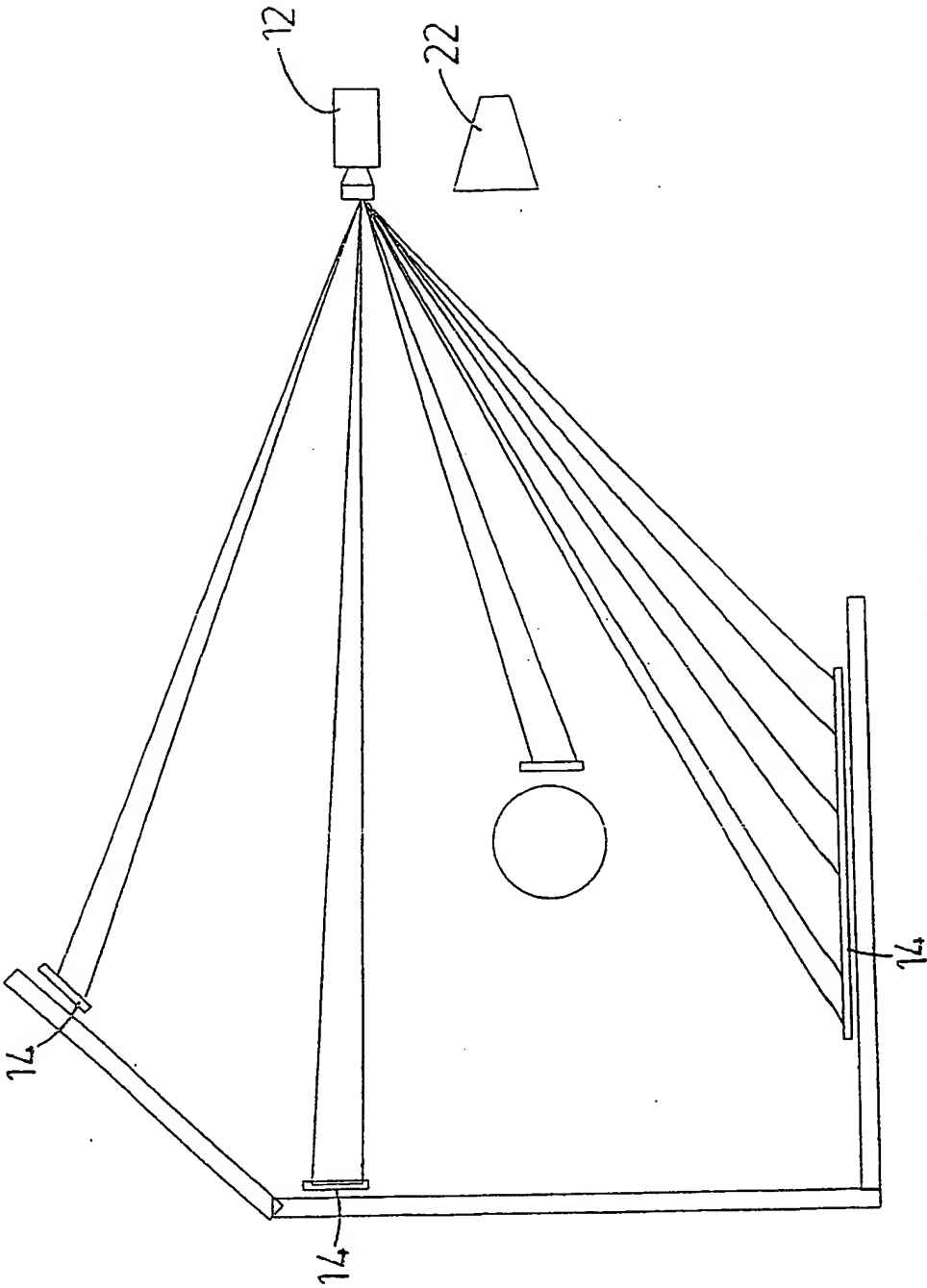


FIGURE 3

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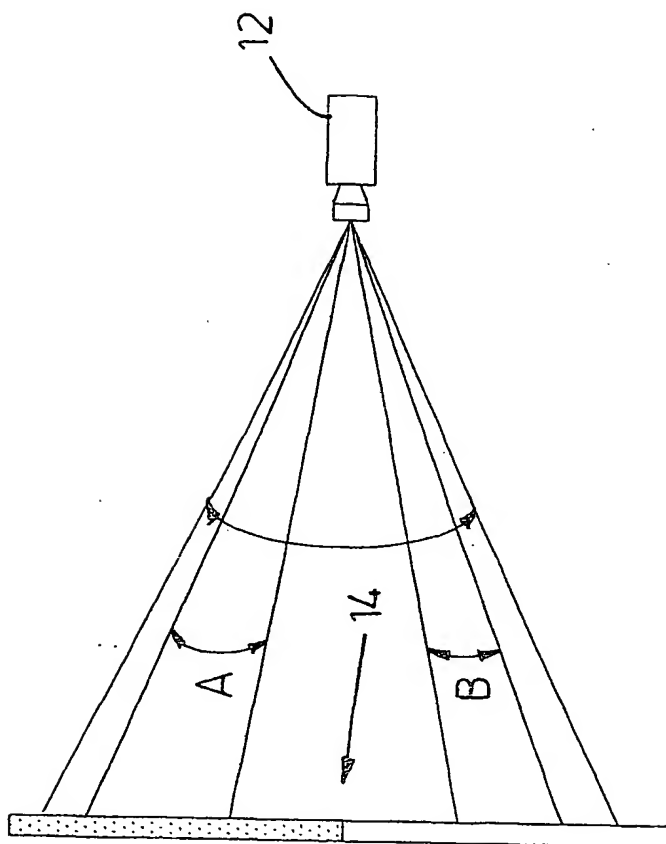


FIGURE 4

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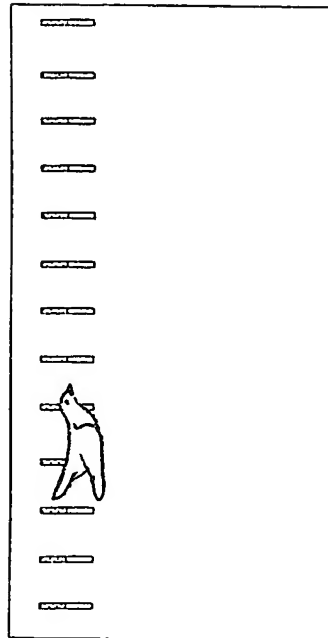
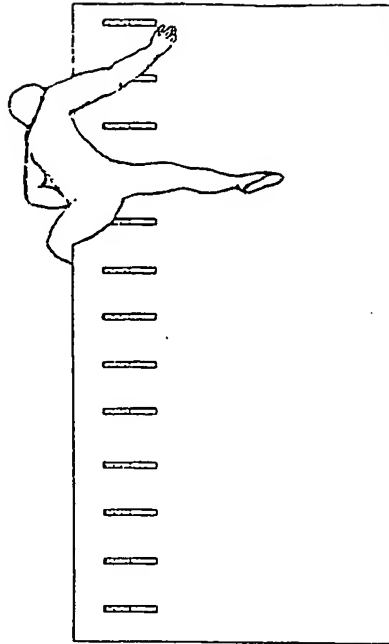


FIGURE 5

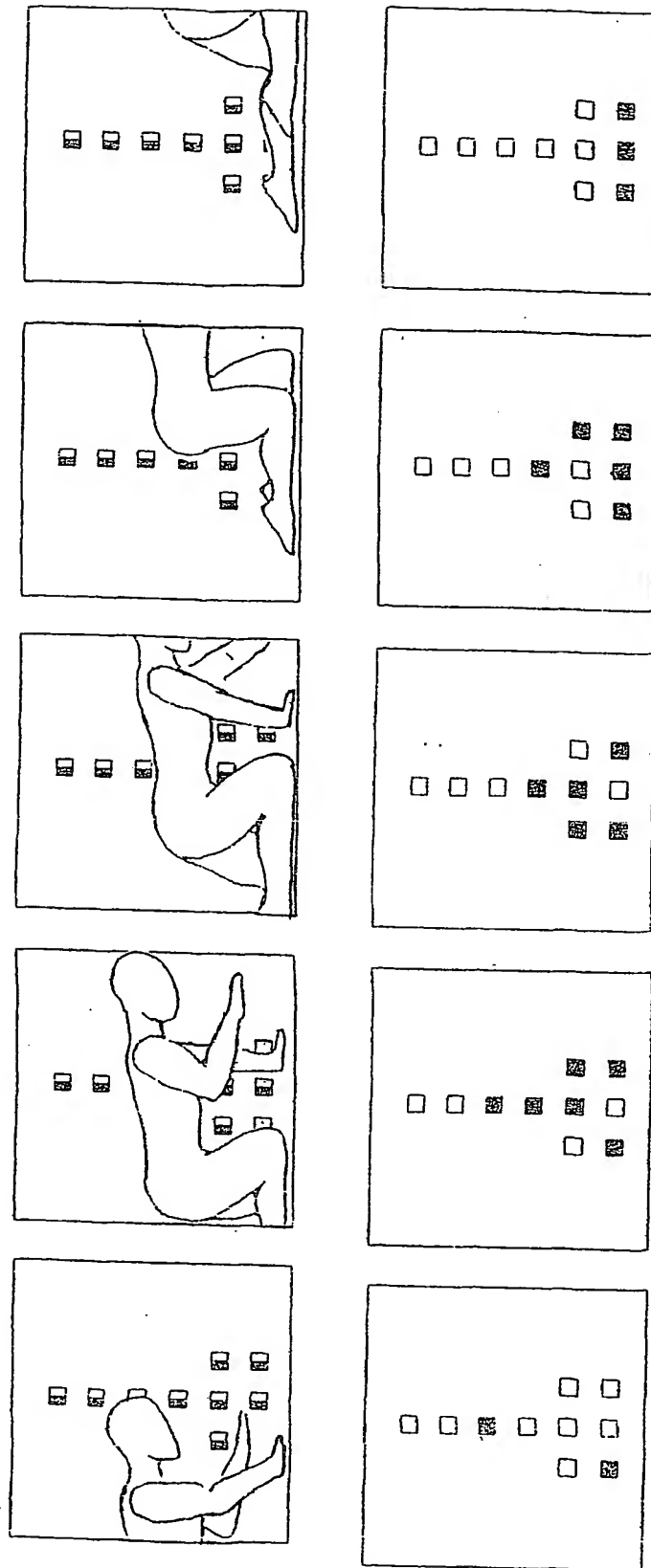


FIGURE 6

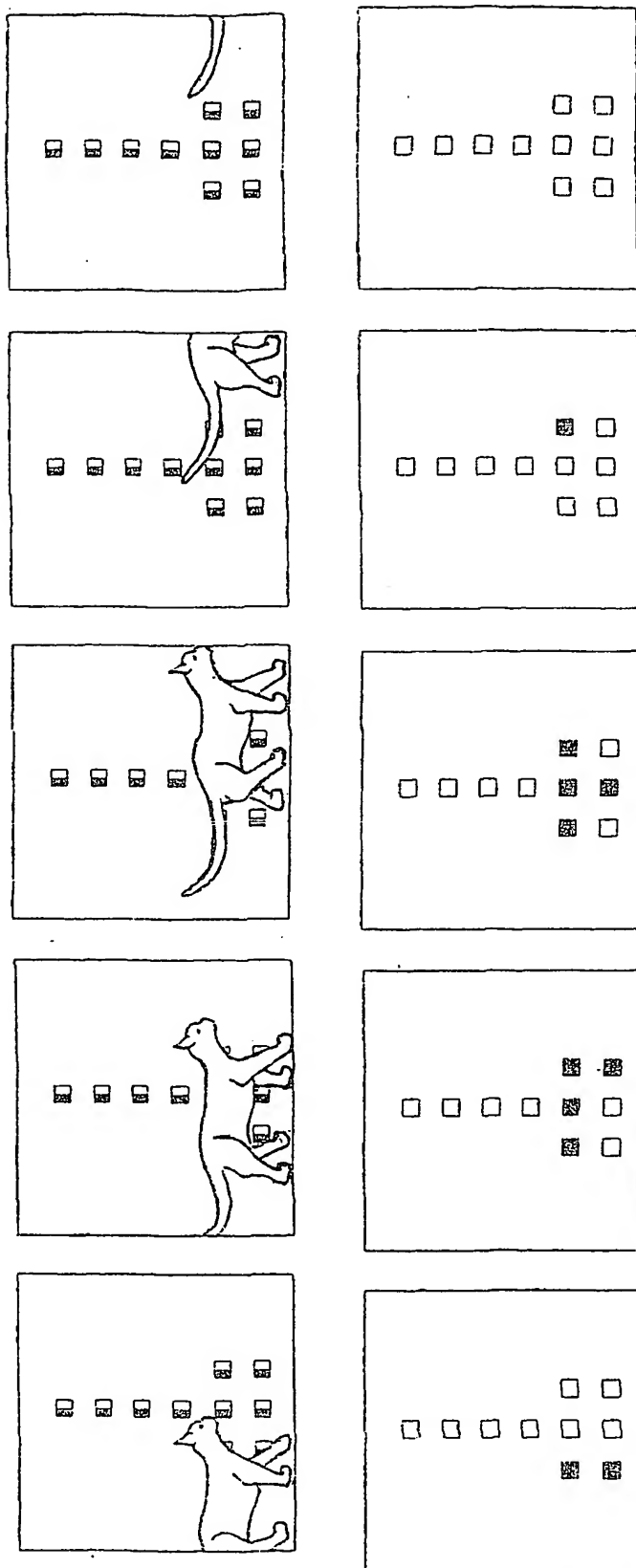


FIGURE 7

INTERNATIONAL SEARCH REPORT

Int: al Application No
PCT/ZA 01/00160

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 608B13/187

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 608B 601V

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 075 238 A (FEMBOEK JOSEF) 13 June 2000 (2000-06-13) abstract	1-17
A	EP 0 747 868 A (ABB PATENT GMBH) 11 December 1996 (1996-12-11) abstract; figure 2	1-17
A	DE 35 25 265 A (UELFER ELECTRONIC GMBH) 22 January 1987 (1987-01-22) abstract	1-17
A	EP 0 033 024 A (CHLORIDE GROUP LTD) 5 August 1981 (1981-08-05) abstract	1-17

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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P document published prior to the International filing date but later than the priority date claimed

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Y document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

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Date of the actual completion of the International search

15 January 2002

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Int. Application No
PCT/ZA 01/00160

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 6075238	A	13-06-2000	DE 19644278 A1 WO 9818026 A2 EP 0876627 A2 JP 11508697 T	07-05-1998 30-04-1998 11-11-1998 27-07-1999
EP 0747868	A	11-12-1996	DE 19520891 A1 DE 59604395 D1 EP 0747868 A1	12-12-1996 16-03-2000 11-12-1996
DE 3525265	A	22-01-1987	DE 3525265 A1	22-01-1987
EP 0033024	A	05-08-1981	EP 0033024 A2	05-08-1981

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